Surface Matters

What Arizonans are doing with geospatial technology

Newsletter of the Arizona Geographic Information Council

Extraterrestrial GIS

Surface Mapping: It's Not Just for Earth Any More

Let's say you live on Earth, but you're interested in studying places other than Earth. Could you, perchance, apply your geographic knowledge to other worlds? Absolutely!

Since the 1960s, scientists have been sending robots to the more interesting parts of the solar system. As a result, scores of geoscience professionals are now applying their skills to other planets. Many Arizonans, as it happens, are at the forefront of this research.

Between our three state universities and the U.S. Geological Survey, a great deal of off-world geography is being studied. Professional researchers, graduate students, photogrammetrists, programmers, and others are constantly adding to our knowledge of the solar system. Within this mass of activity, geographic information science has made its usefulness apparent. GIS has reached outer space!

Making it Work

Applying the methods of GIS to other planetary bodies is a natural extension of the technology. The implementation, however, is more complex. Certain problems arise that Earth-centered people may not consider. To begin with, what is the shape of a given planet or moon? Each has a unique geometry and requires its own mathematical description. Has a geographic coordinate system been established for the body being studied? Does a recognized datum exist? Where is the line of zero degrees longitude? Is there a "sea level" reference?

Adding to these problems is the fact that most commercial GIS packages do not accommodate planets other than Earth. Until very recently that wasn't a shortcoming. The only viable solution has been for planetary science experts to write their own programming. This is where the U.S. Geological Survey steps in. The USGS Astrogeology Team, based in Flagstaff, does a great deal of custom programming and provides other vital services for the planetary science community. Perhaps its most well-known service is the web site it maintains (see pg. 6). The site, meant for professional researchers, allows users to download software and data, participate in discussion forums, ask for help with vexing problems, and perform geographic analysis on various planets. It features an Internet map server with sophisticated capabilities; the map server has been used, for example, to find suitable landing sites on Mars and targets of observation on Saturn's moon Titan.

One example of necessary custom programming can be found at the Mars Lab at Arizona State University, recognized as the world's premiere center of Mars research. The staff at the Mars Lab needed a method of precisely targeting locations of the highest interest. In 2000 they began developing the JMars program, a sort of home-made GIS that allows users to overlay images. Data from any past Mars mission, whether in visible light or infrared, can be used. As different images are stacked, the characteristics of an area become apparent. Is there a lot of sand or dust? Are there lots of rocks, craters, hills, canyons, flow channels? What is the mineral composition? Is ice

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INSIDE THIS ISSUE

President's Message

Timothy Smothers
AGIC President

Welcome to the second edition of *Surface Matters*, the new AGIC newsletter. As the year progresses, AGIC is reviewing opportunities to bring the geospatial community together, and understand how our efforts impact various levels of both government and other geospatial professions. I am writing this introduction while attending the world's largest conference dedicated to the promotion of geospatial activities throughout the world, the 25th annual Environmental Systems Research Institute's User Conference. Sitting back, I realize a common theme is surrounding our environment – the theme of "collaboration."

In the past, GIS hadn't the opportunity to build effective collaborative efforts due to limitations of hardware, software, and data availability. As GIS matured, it became apparent to many that as geospatial professionals we need to step back and take a long hard look at standards, processes, and partnerships – collaborating with our neighbors will provide greater success at all levels in our geospatial activities. Several efforts are occurring that bring the theme of collaboration home. Within our own state, we see the efforts of AGIC to work closely with the Arizona Professional Land Surveyors organization to help bring all geospatial professions closer together. Also, our own State Cartographer, my hero, Eugene Trobia, is working hard with the National States Geographic Information Council (NSGIC) to develop the Fifty States Initiative to assist in the coordination of statewide efforts in GIS collaboration and integration. Last, but far from least, we have the AGIC Conference, whose theme for this year's event is Collaboration: Fitting the Pieces Together. This conference will showcase efforts of various organizations that have benefited from collaborative efforts at a variety of levels.

Due to better software, hardware, and infrastructure to build, store, and push our respective geospatial data about our planet, the task of collaboration has become an idea of this new information age. Observing and identifying the business models of all levels of government, identifying business practices and associating ownership through necessity provides us with tools to realize the benefits of developing, maintaining, and deploying data at appropriate levels. The collaboration between many different entities in defining coordinated strategies, along with standards that allow the use of information (spatial or not) at all levels, has begun.

I'd like to invite all the state's geospatial professionals and decision makers to attend the AGIC Conference in Prescott and discover how collaboration has benefited geospatial activities at all levels within the state, and how future endeavors in collaboration will benefit users from local to state right up to the federal players. ◇

Surface Matters is the quarterly newsletter of the Arizona Geographic Information Council. It is written for those who want to stay in touch with the vision and activities of AGIC and with the continuing growth of GIS in Arizona.

Your comments about this publication are always welcome. Please send all correspondence to the editor.

Readers are invited to submit articles that they wish to be considered for publication. The author retains all copyrights. Please let the editor know if the article has been published elsewhere.

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Planetary GIS

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present? Because it efficiently illuminates such questions, JMars is excellent for locating suitably interesting observation sites for orbiting probes and landing craft. Since the staff quickly realized that it is equally useful for geological analysis, they have been able to focus their attention on the most intriguing Martian puzzles.

Although custom programming has been the norm for planetary scientists, it is no longer the only option. Some researchers are beginning to use ArcGIS and its extensions. Version 9.0, as a matter of fact, supports 71 geographic coordinate systems for different planets and moons.

Not all research is done with state-of-the-art techniques. This is largely due to the nature of the available data. For instance, Venus and Mars have been examined with laser altimeters and radar, resulting in high quality elevation data. For the moons of the outer planets, this is not usually the case. In most instances researchers have to be satisfied with two-dimensional images. Then again, these images often overlap, leading to stereographic pairs from which elevations can be derived.

Reaping the Benefits

Even though extra difficulties come into play when studying bodies beyond the Earth, that hasn't stopped the experts. Throughout our great state, the practitioners of planetary pursuits are making all kinds of fascinating discoveries.

At Northern Arizona University, one area of study is a comparison of the craters on Mars with those on Jupiter's large moon Ganymede. Ganymede's surface is mostly ice, and the impact craters there have characteristics that don't occur on dry, rocky bodies. It is believed that Mars may have subsurface ice. If some craters on Mars have similar characteristics to those on Ganymede, they may indicate areas where ice is present beneath the surface.

Back at the USGS, the Astrogeology group is carrying out a variety of investigations. Its most prominent project is the Cassini-Huygens mission to Saturn. The Cassini orbiter arrived at Saturn in July 2004 and launched the Huygens probe, which landed on the moon Titan in January 2005. Cassini will spend four years orbiting Saturn and sending back data on its rings and moons.

As the Cassini probe passes Titan, it will capture the moon's surface details using radar. The data collected will be processed by Astrogeology scientists and used to construct 3-D models of Titan's surface. The team will also produce stereo images, image mosaics, and maps of the moon's chemical and physical properties. These efforts will be enhanced by data from the Huygens lander, which descended by parachute through Titan's atmosphere. As it slowly fell, the lander took pictures in all directions. These pictures will be correlated with Cassini's radar data to produce more detailed information about the surface.

Heading south to ASU again, we find research into another distant moon, Europa, which orbits Jupiter. Using a program called ISIS (developed by the Astrogeology folks), investigators on the recent Galileo mission used older Voyager images to determine ahead of time which features of which moons to focus on. When new pictures were received from Galileo, images showing stress fractures and ridges on the icy surface of Europa were analyzed. Younger ridges had different orientations than older ones, indicating that the crust had rotated above a subsurface ocean of water, detached from the mantle below, during the period of fracture and ridge formation.

At the University of Arizona, still more research is under way. Most of it is done at the Lunar and Planetary Lab in the Department of Planetary Sciences. Currently the major focus is the Phoenix project, to be launched in 2007. Phoenix is a craft that will land at the north pole of Mars and sample the surrounding terrain. The university's astrogeologists are mapping potential landing sites, using stereo images to determine if the sites are safe.

Other research at UA involves Jupiter's volcanic moon Io. Galileo's images of Io are being compiled into a mosaic, using the ISIS program, at the USGS. A database containing all of Io's identified surface features and their latitude/longitude coordinates is being assembled at UA. With ISIS a researcher can view the appropriate lat/long grid, locate coordinates, pan and zoom through the images, change the projection, and make measurements of features. Using ISIS, the images, and the database, UA researchers have revealed much of the nature of Io.

Some startling discoveries have been made. More than 500 volcanoes enliven its surface, and dozens of hot spots have been identified. Although it is about the size of Earth's moon, Io has ridiculously tall mountains, some higher than Mount Everest! Most of the volcanic craters, instead of being at the summits of peaks, are on the ground next to the mountains and lie at the same level as the surrounding plains. They exist as volcanic depressions in the ground and don't conform to our usual notions of what volcanoes should look like.

Meanwhile, our own moon is under scrutiny. Its history is being studied by viewing the surface in different wavelengths of light. The different wavelengths reveal subtle variations in surface coloration and composition, which can be used to determine whether a given crater is older or younger than its surrounding neighbors. It's possible, then, to build layers showing craters according to relative age (old, middle, young) and reconstruct the cratering history of the moon.

Many more space probes will be sent to planetary bodies over the next decade. NASA, the European Space Agency, and Japan are all working on new projects. Between now and 2015, spacecraft will be sent to Mercury, Venus, the moon, Mars, a comet, an asteroid, and even Pluto! Some will be orbiters, some will be landers, and two will return samples (one from the asteroid, one from Mars). With this in mind, it's clear that opportunities to apply GIS to distant worlds will continue well into the future. ◊

See page 6 for related links.

Hydrology and GIS

Carlos Carriaga, PhD, PE
Project Manager, Dibble & Associates

The widespread availability of global and regional data sets through the Internet has made GIS a very powerful technology in our present day – applicable to almost every facet of human endeavor. Gone are the days when GIS was used only for mapping and nothing more – the evolution has blazed through every discipline and profession imaginable. In engineering, the influence of GIS has been steadily gaining ground and dramatically making its relevance more apparent as engineers see the value of information-based technology to the industry.

Water engineering, for instance, which involves the quantification, control, management, and use of water, requires a multi-disciplinary approach to harness this valuable resource. If not properly managed and controlled, however, the same resource that brings life can also threaten life in the form of flood.

Hydrology, which is defined as the science of studying the properties, distribution, and effects of water in both the atmosphere and the earth's surface, has greatly benefited from the evolution of GIS.

This article is written to focus on the recent advances of surface water hydrologic modeling due to GIS. Such an advance is so revolutionary that the same could also be expected to happen in other engineering fields.

Data Sets for Hydrology

Water flowing in a stream is always a fascinating reality. In arid regions such as Arizona, dry riverbeds and washes can suddenly transform into flowing streams when a storm occurs. As engineers, the quantification of flow is important for the design of storm water facilities. The process of quantifying flows from a watershed, however, is not always straightforward.

The three most important data sets for hydrologic modeling are the topographic data, the soil map, and the land use coverage. The topographic data, comprised of elevation contour lines or "gridded" elevation data, is the basis of watershed delineation and stream network identification. GIS-based modeling programs such as the Watershed Modeling System (WMS) employ digital elevation models for the delineation of watersheds and the discretization of a drainage data set. A comparable program that accomplishes the same task is HEC-GeoHMS, which interfaces with ArcView GIS 8.3 and Spatial Analyst. Both programs integrate soil and land use maps with delineated watersheds to develop model parameters for standard models, such as the TR-20 model from the Natural Resources Conservation Service (NRCS) and the Hydrologic Engineering Center's HEC-1 and HEC-HMS programs.

Data Sources

Digital elevation models (DEM) are digital representations of cartographic information in a raster form. DEMs consist of a sampled array of elevations for a number of ground positions at regularly spaced intervals. These digital cartographic/geographic data files are produced by the U.S. Geologic Survey (USGS) as part of the National Mapping Program and are produced in 7.5-minute, 15-minute, 2-arc second (also known as 30-minute), and 1-degree units.

The land use coverages are available from the USGS and the Environmental Protection Agency (EPA). Some Internet sites such as WebGIS offer land use coverages but only for limited geographic areas. Most current land use information, however, is acquired through local government agencies such as city governments or county agencies, which regularly update information on land use within their jurisdictions.

The soil data sets are available from NRCS and EPA. The U.S. Department of Agriculture maintains a website, the National Cartography and Geospatial Center (www.ncgc.nrcs.usda.gov), on which are numerous links and descriptions of geospatial data sets. Through these links it is possible to acquire soil type maps from the two main soils databases: STATSGO and SSURGO, the State Soil Geographic Database and the Soil Survey Geographic Database. The EPA site, on the other hand, offers STATSGO soil data in one large "core data" download.

GIS-Based Modeling Packages

The Watershed Modeling System, developed by Environmental Modeling Systems, is a comprehensive graphical modeling environment for all phases of watershed hydrology and hydraulics. It includes powerful tools to automate modeling processes such as basin delineation, geometric parameter calculations, and GIS overlay computations. Such computations can involve parameters like curve numbers, rainfall depth, and roughness coefficients. WMS also supports standard hydrologic modeling for HEC-1 (HEC-HMS), TR-20, TR-55, the Rational Method, the Modified Rational Method (MODRAT), National Flood Frequency (NFF), and the Hydrologic Simulation Program (HSP).

Another popular modeling procedure involves the use of ArcGIS 8.3, Spatial Analyst, HEC-HMS, and its GIS extension HEC-GeoHMS. These separate programs, when used together like a single package, utilize the same data sets to develop the hydrologic model, from watershed delineation to the extraction of model parameters for the HEC-1 or HEC-HMS model.

Project Applications

The engineers at Dibble & Associates have made wide use of hydrologic models and GIS throughout Arizona. Two examples are given here.

The Watershed Modeling System was used to develop hydrologic models for the City of Sedona

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GIS at the University of Arizona

This is our first look at GIS education in Arizona. We will survey different institutions in the state and report on what levels of GIS instruction they have available.

At the University of Arizona, GIS software is used in disciplines all over the campus. From geography and natural resources, to geoscience, to anthropology, agriculture, mining engineering, and even medicine, professors and students are performing geographic analysis. This is not to say that they're all becoming GIS experts; far from it. Rather, the principles of geographic analysis have made their way into subjects across the spectrum of education.

Academics

Classes that specifically teach GIS are offered through the Department of Geography and Regional Development and the School of Natural Resources. Some can be taken for credit in either department, and two of the classes are taught jointly between Geography and Natural Resources; that is, different instructors teach different topics in these classes during the semester. Eight classes in total are available, but that does not include related courses like remote sensing, image processing, or surveying. Other courses that rely on geography are found in various departments, depending on the discipline being pursued.

Students who enroll in GIS classes have two primary computer labs on campus in which to do assignments, one in Geography and the other in Natural Resources. In the Geography Department it is the Spatial Analysis Lab, which is mostly used for formal labs but sometimes serves as the classroom for one of the courses. It has thirty seats and is used for both GIS and remote sensing. In addition to this lab, Geography also operates the GeoVisualization Lab, which is used for research projects and upper-level GIS courses. The GeoViz Lab has its own web site which lists current projects being conducted there. In the School of Natural Resources the main location is the Instructional Computing Facility, where labs are held for a variety of classes. After their formal lab hours students can use a second lab called the Open Computing Facility.

For those who want GIS to be an integral part of their studies, the Geography Department offers an undergraduate GIS minor. This is the only such undergraduate minor at the university. Within the School of Natural Resources, graduate students majoring in natural resources can take a minor called Natural Resources Information Systems. On the PhD level, students can arrange to take a minor called Remote Sensing and Spatial Analysis. This is an inter-disciplinary program that requires students to take classes from a core group, plus additional classes from their majors.

Another option, still awaiting approval by the Arizona Board of Regents, will be the much-anticipated Geographic Information Science Certification Program, which will be available at the graduate level. This program was developed cooperatively between the School of Natural Resources and the Department of Geography and Regional Development. Although not yet available, many students have already expressed interest and the colleges are anxious to get it started.

Work Experience

Students can gain valuable experience in GIS and related disciplines by seeking out jobs that become available on campus and off. On-campus jobs can include working in a computer lab, being a research assistant, or working in one of the university's research facilities. Three such facilities that use GIS, remote sensing, and related technologies are the Center for Applied Spatial Analysis (CASA), the Advanced Resource Technology Group (ART), and the Arizona Remote Sensing Center (ARSC). These facilities typically hire graduate students.

Off-campus jobs are usually with local government offices, though sometimes a Federal office like the U.S. Geological Survey or the Department of Agriculture will have a position available. In most cases a manager at a given agency will contact a professor with the job information. The professor then posts a job notice and it's up to the students to take it from there. The procedure is very decentralized, but many undergraduate and graduate students find valuable employment. Of course the university also operates the Career Services Center, through which students can look for on- or off-campus jobs, work-study programs, and internships.

Finally, students and teachers alike can sign up for the university's GIS listserve, a group e-mail account in which members can exchange information and ideas, ask for help with GIS problems, and post job notices.

Further Information

University of Arizona: http://www.arizona.edu
Admissions Office: http://admissions.arizona.edu
College Catalogs:
http://catalog.arizona.edu/allcats.html
School of Natural Resources:
http://www.ag.arizona.edu/srnr
Department of Geography and Regional Development:
http://geog.arizona.edu
GeoVisualization Lab: http://geoviz.geog.arizona.edu
Center for Applied Spatial Analysis:
http://www.casa.arizona.edu
Advanced Resource Technology Group:
http://www.ag.arizona.edu/art
Arizona Remote Sensing Center:
http://www.arid.arizona.edu/Divisions
Career Services: http://www.career.arizona.edu

GIS listserve: uagis@ag.arizona.edu ◇

AGIC 2005 GIS Conference

Jason Howard
Conference Chair

The AGIC Conference is less than two months away and the planning is going well. This year's gold sponsor is ESRI and our silver sponsors are Allen Instruments and Supplies, Hewlett-Packard, Holman's, and Southern Arizona Institute of Advanced Training.

The conference is October 26-28 in Prescott at the Prescott Resort and Conference Center. I encourage you to attend, especially if you are new to the Arizona GIS community. The AGIC Conference is the only conference for geospatial professionals in Arizona. It's a great place to make new contacts and find out what people are doing with GIS around the state.

The theme of this year's conference is Collaboration: Fitting the Pieces Together. Collaboration and cooperation among governments, universities, and private companies offers hope that in times of fiscal scarcity, big projects can be undertaken if the burden does not fall solely on one organization. The goal of this year's conference is to highlight those organizations and projects that have found success through collaborative partnerships.

For more information visit us online at http://agic.az.gov/agic2005, or contact me at (602) 542-3249, jhoward@land.az.gov. ◇

Planetary Science Links

ASU Planetary Exploration Lab
http://tes.asu.edu/pel_index.html

ASU Planetary Geology Group
http://europa.la.asu.edu/

JMars – Downloadable software!
http://jmars.asu.edu/

NAU Department of Physics and Astronomy
http://www.physics.nau.edu/

UA Lunar and Planetary Lab
http://www.lpl.arizona.edu/

USGS Planetary GIS Web Server
http://astrogeology.usgs.gov/Projects/webgis

All space images on page 1 courtesy of NASA.

Hydrology and GIS

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Storm Water Master Plan. The five watershed models developed were for five major drainage basins including portions of Oak Creek. The topographic data within the municipal boundaries were provided by the City and augmented with U.S. Geological Survey DEMs for areas outside the city limits.

The development of a hydrologic model for the Florence Retarding Dam was done for dam and public safety considerations. WMS was used in the delineation of the 61.1 square mile watershed and the development of the TR-20 model. The TR-20 model was used to provide estimates of peak flow for various studies such as flood damage analysis involving the 100-year flood event; flood risk assessment analysis involving 10-year, 25-year, 50-year, and 100-year flood events; and the emergency spillway design analysis involving probable maximum precipitation (PMP). ◇

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AGIC Board Member

AGIC Roundup

• The annual conference of the National States Geographic Information Council will be held September 25-30 in Rochester, NY. AGIC President Tim Smothers, Vice President Rick Harrington, and State Cartographer Gene Trobia will attend. Mr. Smothers will give a brief talk about AGIC activities over the past year.

• A letter of support is being issued from Congressman J. D. Hayworth's office requesting an additional $3 million be added to the NOAA Geodesy budget for Arizona to conduct Height Modernization. This letter will be circulated to the Arizona Congressional delegation for their support and endorsement. The State Cartographer's Office is working with the Governor's Office and representatives of the private sector to provide information to the Arizona delegation and explain why their support of Arizona Height Modernization is important for governmental agencies and the public.

• Several members of the AGIC Board are working with the Arizona Professional Land Surveyors Geospatial Committee to develop spatial data standards for GPS data in Arizona. The aim is to provide useful guidelines for both the GIS and surveying communities.

• The Technology Committee is moving forward with the GIS Data Portal. The data from the Arizona Land Resources Information System (ALRIS, a part of the State Land Department) are on the server and ready to go. A draft Interagency Service Agreement is being developed for agencies that want to contribute data.

• The Data Resources Committee is putting together a project plan to purchase and set up an SDE server to be used with the GIS Data Portal. The server will be used to house aerial photographs of Arizona. These images are planned to be in the public domain and will be available for viewing through the Portal.

• The State Cartographer's Office is assembling a work group to participate in the National Agriculture Inventory Program (NAIP). The work group will develop a plan so that NAIP orthoimagery is flown digitally, resulting in 1-meter natural color images over all of Arizona. The work group will also develop a plan to update Arizona imagery on a regular basis. The U.S. Department of Agriculture is scheduled to fly Arizona in 2007.

Calendar of Events

NORTHERN ARIZONA GIS USER GROUP MEETING
FRIDAY, SEPTEMBER 16
8:00 AM – 12:00 NOON
SOUTHWEST FORESTRY SCIENCE COMPLEX, BUILDING 82
PONDEROSA MEETING ROOM
110 EAST PINE KNOLL ROAD
NORTHERN ARIZONA UNIVERSITY, FLAGSTAFF
CONTACT: AARON SEIFERT, ASEIFERT@SWIAZ.COM

TUCSON AREA GIS COOPERATIVE MEETING
TUESDAY, SEPTEMBER 20
3:00 – 4:30 PM
CITY INFORMATION TECHNOLOGY DEPT., PUEBLO ROOM
481 W. PASEO REDONDO, TUCSON
HTTP://WWW.TUCSONAZ.GOV/GIS

LSIT/RLS REVIEW SEMINAR
SEPTEMBER 23-24
REGISTRATION DEADLINE SEPTEMBER 16
THIS SEMINAR IS TO HELP SURVEYORS PREPARE FOR THE ARIZONA LSIT/RLS EXAM
HARRAH'S AK-CHIN RESORT
15406 MARICOPA RD, MARICOPA, AZ
HTTP://WWW.AZPLS.ORG

AGIC 2005 GIS CONFERENCE
OCTOBER 26-28
PRESCOTT RESORT AND CONFERENCE CENTER
CONTACT: JASON HOWARD, JHOWARD@LAND.AZ.GOV
HTTP://AGIC.AZ.GOV/AGIC2005
EARLY REGISTRATION BY SEPTEMBER 23 – SAVE 20%!

AGIC QUARTERLY BOARD MEETING
THURSDAY, NOVEMBER 3
1:30 – 3:30 PM
ARIZONA DEPARTMENT OF ADMINISTRATION
100 N. 15TH AVE., ROOM 300, PHOENIX
HTTP://AGIC.AZ.GOV/BOARD/MEETINGS.HTM

GIS DAY
WEDNESDAY, NOVEMBER 16 – EVERYWHERE!
GIS DAY IS A GRASSROOTS EVENT IN WHICH GIS PROFESSIONALS OPEN THEIR DOORS TO SCHOOLS, BUSINESSES AND THE PUBLIC TO SHOW HOW THE TECHNOLOGY IS USED. IN RECENT YEARS GIS DAY ACTIVITIES HAVE BEEN HELD IN CITIES ACROSS ARIZONA. TO READ ABOUT PAST EVENTS OR GET IDEAS FOR HOLDING YOUR OWN, VISIT HTTP://WWW.GISDAY.COM